

**Product Development Team
for
NEXRAD Enhancements**

Quarterly Report – 2nd Quarter FY 00

00.6.1 Damaging Winds

Development and enhancement of the Damaging Downburst Detection and Prediction Algorithm (DDPDA) to ensure that it meets the aviation communities' needs for the prediction and detection of damaging winds associated with both wet and dry atmospheric environments, along with larger scale downbursts.

a) Current efforts

Work during the 2nd quarter focused on expansion of the DDPDA events database. Ten downburst days from the southeastern United States were examined, and six of these days were added to the database totaling nine severe downbursts and 256 null events.

Several DDPDA output parameters continue to be examined in the development of downburst prediction equations. It was determined that the calculation of several important parameters could be improved. This will entail a few minor software changes, and should improve the output of the discriminant analysis that is used to create the downburst prediction equations.

b) Planned Efforts

Overall efforts this fiscal year include finalizing the algorithm process and moving it into the framework of the ORPG. Work during the next quarter will focus on expanding the size of the database, improving the quality of the prediction parameters, and development of a downburst prediction equation based on new data.

c) Problems/Issues – none.

d) Interface with other organizations – none.

e) Activity schedule changes

There have been several delays in the formalization of the FY00 DDPDA tasking. Because of this, and re-thinking of what needs to be done with DDPDA, Milestone 00.6.1.E1 will not be met. It is requested this milestone be moved to 30 September 00.

00.6.2 Polarization and Frequency Diversity

Continue development of algorithms that utilize polarization data to detect and predict the movement of the volumetric extent of hydrometeors such as hail, rain, snow, sleet, icing conditions, and freezing rain that are hazardous to aircraft.

a) Current Efforts

Activities during the past quarter have concentrated on microphysics of the melting layer and icing cases from the Mesoscale Alpine Programme (MAP), and studies of hydrometeor classification sensitivity.

In particular the melting layer study examined datasets from 20 August and 2 September 1998 from Florida and 25 September 1999 from MAP. Of particular interest is the distribution of temperature relative to the vertical profile of polarimetric variables. The radar data depict heights at which aggregation increases rapidly, wobbling begins, and the base of the melting layer is found. The reflectivity maximum is close to, or slightly below the melting level. The other parameters (Zdr, rho_hv, and LDR) have their greatest signatures at a somewhat lower level. The polarimetric variables (particularly rho_hv and LDR) often have melting signatures in convective cases when reflectivity, and often Zdr, fields do not have signatures.

The search for icing indicators is difficult. In the MAP 20 September 1999 case, supercooled water was isolated but largely occurred in regions of low radar reflectivity. The 25 September case showed supercooled liquid and ice particles were mixed. Polarimetric signatures are dominated mostly by aggregates. Because the particle probes showed ice particles in the icing regions to be heavily rimed, we are searching for a signature that might indicate the riming. Noise problems have been found in the LDR and rho_hv measurements at low power levels. This causes what may be false supercooled water signatures on the fringes of the precipitation. The noise may be a product of a mismatch in the beam patterns, which is being examined.

Examination of the data reveals the need for a dedicated experiment for the particle identification work. Coordination with the aircraft during S-POL data collection in MAP was not well planned. At times the aircraft operated in regions outside the radar data collection area. Also, regions of data collection interest were large, consequently at times temporal sampling is on the order of 10 minutes between the radar and aircraft. Much of the icing is associated with small convective units that have short lifetimes, further complicating the co-location of the aircraft and radar in the icing regions. During PRECIP98, another project in which aircraft observations were available, the aircraft generally operated at distances greater than 60 km from the radar. Because of this, the precise definition of melting layer location and changes in particle types were made difficult by beam broadening. What this all suggests is the need for a dedicated field experiment such as the upcoming JPOLE project.

The sensitivities of the hydrometeor classification algorithm to various polarimetric variables continue to be investigated. This study includes:

- 1) A subjective comparison of the fields of hydrometeors obtained using the full set of available polarimetric variables against a subset where some variables have been left out.
- 2) Qualitative evaluation of relative importance of polarimetric variables.

The comparisons reveal that the reflectivity factor (Zh) and differential reflectivity (Zdr) combined have the strongest discriminating power. Inclusion of the temperature profile helps eliminate a substantial number of spurious errors. Although the absence of temperature (T) information degrades the scheme, it appears that the resultant fields are generally coherent and not far from the fields obtained by adding temperature to the suite of polarimetric variables.

The qualitative comparison of the effects of polarimetric variables was done by defining several metrics based on set theory. The relative importance of the polarimetric variables is ranked based on these metrics. The analysis of an S-POL Florida case and a Cimarron Oklahoma case reveals that the (Zh, Zdr) combination is the most important variable pair for the hydrometeor classification, followed by (Zh, T) and then (Zh, Kdp).

A basic question driving this work is whether or not LDR is essential in the classification scheme and must be part of the ORDA. The results of the sensitivity study support that LDR might not be essential (at least for convective storms). Further investigations are needed to determine its relative value in other precipitation systems. In absence of a comparative temperature profile, LDR appears to be important in distinguishing between light rain and dry snow.

b) Planned Efforts

The main efforts throughout the next quarter will be to continue analysis of the cases discussed above and the sensitivity testing. These efforts will provide both better observational interpretation and quantitative assessment of the classification algorithm. In addition, the S-POL radar will be deployed 3 May to eastern Colorado in support of STEPS. Setup is expected to be finished and data collection started about 19 May. STEPS will continue through about 15 July. It is planned to have a NEPDT representative on-site during most of the program.

c) Problems/Issues – none.

d) Interface with other organizations – none.

e) Activity schedule changes

Milestone 00.6.2.2E1 continues to be ongoing. This should be finished before the end of May. With the deployment of S-POL and the STEPS dates now set, Milestone 00.6.2.3E1 will be finished by May and Milestone 00.6.2.4E1 finished by mid-May.

00.6.3 Circulations

Continue to enhance NSSL's Mesocyclone Detection and Tornado Detection Algorithms (MDA, TDA) while developing in parallel a new algorithm which combines MDA and TDA into one algorithm which detects and analyzes all circulations - the Vortex Detection and Diagnosis Algorithm (VDDA).

a) Current efforts

i) MDA vs. VDDA Decision Briefing

The OSF Directors have made the decision to implement the NSSL MDA into the next feasible ORPG Build (most likely Build 3, slated for Sept 2002). Efforts after the decision during this quarter include the initial work to scope out the needed tasks and milestones to proceed with MDA implementation.

ii) MDA/TDA Database

A new suite of students has been hired under separate funding to greatly expand the MDA and TDA database for statistical development of the NWS Tornado Warning Guidance. All database efforts will be shared in the development of circulation detection algorithms for the FAA. No new cases were added during this quarter, but we anticipate many more new cases to be added in the 3rd and 4th quarters.

Many of the more interesting cases in the database are given an individual analysis and the results can be found at:

www.nssl.noaa.gov/teams/swat/Cases/cases_pix.html

The entire data set was processed with the 88D-Mesocyclone Algorithm using a set of adaptable parameters that mimic the lowest thresholds used in the NSSL MDA for additional comparison purposes. Evaluation results will be reported in the next quarterly report.

NSSL has begun the effort of developing a Web-based method to truth and evaluate the MDA and TDA. This will include extensive documentation and downloadable software such that NWSFO field users of the algorithms can use WATADS to develop databases similar to those developed at NSSL to add to a much larger nationwide database.

b) Planned efforts

The main goals of the 3rd quarter are to continue adding cases to the MDA/TDA database, and planning the steps of MDA implementation within Open Systems. A design review with the various branches involved in the implementation will be conducted. Once that occurs the implementation path will be started.

c) Problems/Issues

As the OSF has decided to implement MDA, a question arises as to how to proceed with Task 00.6.3.2 – continue development of newest circulation techniques, and Milestone 00.6.3.2E1 – complete latest circulation studies. These tasks are expected to be delayed until MDA implementation is well underway.

d) Interface with other organizations – none.

e) Activity schedule changes

As mentioned, Task 00.6.3.2 needs to be re-thought as to when it may be acted upon, and a new date for Milestone 00.6.3.2E1 set.

00.6.4 Technical Facilitation

Continue to work through the process of algorithm transition to the operational WSR-88D system. This also includes development of a Common Operations Development Environment (CODE) and Application Programmer Interfaces (APIs) for a more rapid integration of algorithms into the operational system.

a) Current efforts

During the second quarter, significant progress has been made in developing the infrastructure to support adding new algorithms for execution within the ORPG. This includes work on the base data access services, generalization of the output types, and display of algorithm results. In addition, a redesign of the user interface was undertaken to improve product selection, animation, and integration of new maps.

During the second quarter, a new version of the ORPG was incorporated into the CODE baseline. Many changes had to be made in the CODE infrastructure to accommodate changes in the ORPG. These changes were so significant that it was determined it would be best to not release CODE 1.0 until the ORPG test/fix cycle was complete and there is confidence that the ORPG would change little if any over the next 6-12 months. After discussions with the ORPG group, the NWS, and the OSF, it was determined that one month following the end of the ORPG test/fix should be the target for release of the ORPG. Test/fix is scheduled to end on 21 April.

b) Planned efforts

Development and testing for release of CODE 1.0 will continue in the third quarter, with the release scheduled for 21 May.

c) Problems/Issues – none.

d) Interface with other organizations

We will continue to coordinate this activity with the NWS/Office of Systems Development, and Mitretek.

e) Activity schedule changes

With the changes in the ORPG infrastructure and the test/fix cycle, it is believed the schedule below represents a more reasonable timeline, and the NEPDT are requesting these milestone and deliverable changes.

- 00.6.4.1 System review of CODE version 1.0, start 24 April 00.
- 00.6.4.E1 Deliverable - CODE version 1.0 to OSF 21 May 00.
- 00.6.4.2 CODE version 1.0 testing by selected users, start 24 May 00.
- 00.6.4.E2 Milestone - complete version 1.0 testing - 31 August 00.
- 00.6.4.3 Define CODE version 2.0 requirements, start 21 April 00.
- 00.6.4.E3 Milestone - complete version 2.0 requirements - 21 May 00.
- 00.6.4.4 CODE version 2.0 development, start 24 May 00.
- 00.6.4.E4 Deliverable - CODE version 2.0 to OSF - 1 December 00.
- 00.6.4.5 OSF testing of version 2.0, start 1 December 00.
- 00.6.4.E5 Milestone - complete version 2.0 testing - 1 February 01.
- 00.6.4.6 Define CODE version 3.0 requirements - start 15 December 01.
- 00.6.4.E6 Milestone - complete version 3.0 requirements - 1 February 01.
- 00.6.4.7 Finalize CODE version 2.0 for field release, start 1 February 01.
- 00.6.4.E7 Deliverable - version 2.0 to field users - 1 March 01

00.6.6 Rapid Update

Develop software that produces algorithm output after each tilt, thus providing immediate information to the users.

a) Current efforts

Work on this tasking for FY 00 has not yet started.

b) Planned efforts

Rapid update testing and development is expected to begin again by May. Plans include testing and enhancement of the rapid update software and real-time testing towards the end of the FY-00 convective season.

c) Problems/Issues – none.

d) Interface with other organizations - none.

e) Activity Schedule Changes

Because of the startup delay of this tasking, Milestone 00.6.6.E1 will not be met. It is requested this milestone be moved to 31 July. Milestone 00.6.6.E2 should be met as real-time testing can still be accomplished before the end of the convective season.

00.6.7 Cell and Area Tracking

Integration of the Storm Cell Identification and Tracking (SCIT), the Correlation Tracking (CT) and Scale Separation (SS) algorithms into a single multi-scale precipitation tracking and forecast package.

a) Current efforts

NSSL has continued the effort of benchmark testing between MIT/LL's and NSSL's SS/CT implementation. Testing results continued to show that NSSL's implementation is less accurate than MIT/LL's SS/CT version. In order to track down the differences, NSSL's version was modified to read in the MIT/LL filtered data, while turning off the NSSL filtering. Results revealed a problem with the "Bad Value" parameter. The problem was fixed and NSSL's version of SS/CT was run and scored again using the full 160x160 array including the FFT approach. The scores improved over those reported in the FY99 final report (see Table 1), but still remain 3-5% below those found using MIT/LL's software. It has been decided to examine the bilinear interpolation and advection methods as the next area of possible sources of differences between the two versions.

Table 1 shows the latest forecast scores for 2 cases. The scores are derived by comparing the forecast composite reflectivity images to the actual reflectivity fields for a given time.

Table 1. Average POD, PFA, and CSI for 30 and 60 minute forecasts from the NSSL versions of the SS/CT software.

NSSL SS/CT Results using FFTs							
30 minute scores				60 minute scores			
	POD	PFA	CSI		POD	PFA	CSI
03/30/98	89%	8%	83%	03/30/98	68%	22%	59%

06/04/98	83%	10%	77%	06/04/98	64%	24%	56%
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b) Planned efforts

Work during the 3rd quarter will include examination of the bilinear interpolation method and the advection scheme used by MIT/LL, to be sure that NSSL is performing these processes in the same manner as MIT/LL.

c) Problems/Issues

Discrepancies between the implementation of the two versions of the SS/CT continue to be elusive. NSSL will continue to track down these differences. If problems are not readily resolvable through teleconferencing and email, NSSL personnel will travel to MIT/LL to discuss the remaining problems.

d) Interface with other organizations – none.

e) Activity schedule changes – none.

00.6.9 Composite Products

Develop high resolution radar layer products that are rapidly updated.

a) Current efforts

Activities for the second quarter include testing a three-dimensional objective analysis scheme for interpolating radar data onto a Cartesian grid. The Cartesian grid is uniformly spaced in the horizontal and uses a sigma coordinate in the vertical. Using the sigma coordinate, the vertical resolution is high at lower levels and relatively coarse at upper levels. This vertical sampling scheme comes closest to the WSR-88Ds current sampling characteristics. The grid's spacing in the horizontal and in the vertical are adaptable parameters, which can be specified by the user.

The interpolation scheme uses a Barnes-type weighting function, which is designed to retain most of the features observable by radars while filtering the data as wanted. A quality control (QC) procedure, including prototype ground clutter and anomalous propagation (AP) removal algorithms, is performed before the objective analysis. An inverse-distance weighted mean scheme is used for combining data from multiple radars in regions where overlapping occurs.

The QC procedure and the analysis scheme have been initially tested using data from two radars (KIWA and KFSX) in Arizona. Fig.1a shows the example analysis domain (shaded area in the central Arizona) and Fig.1b shows the topography in the analysis domain. The horizontal resolution is 1km and the

vertical resolution varies from 200m near the ground to 1km at the top of the domain.

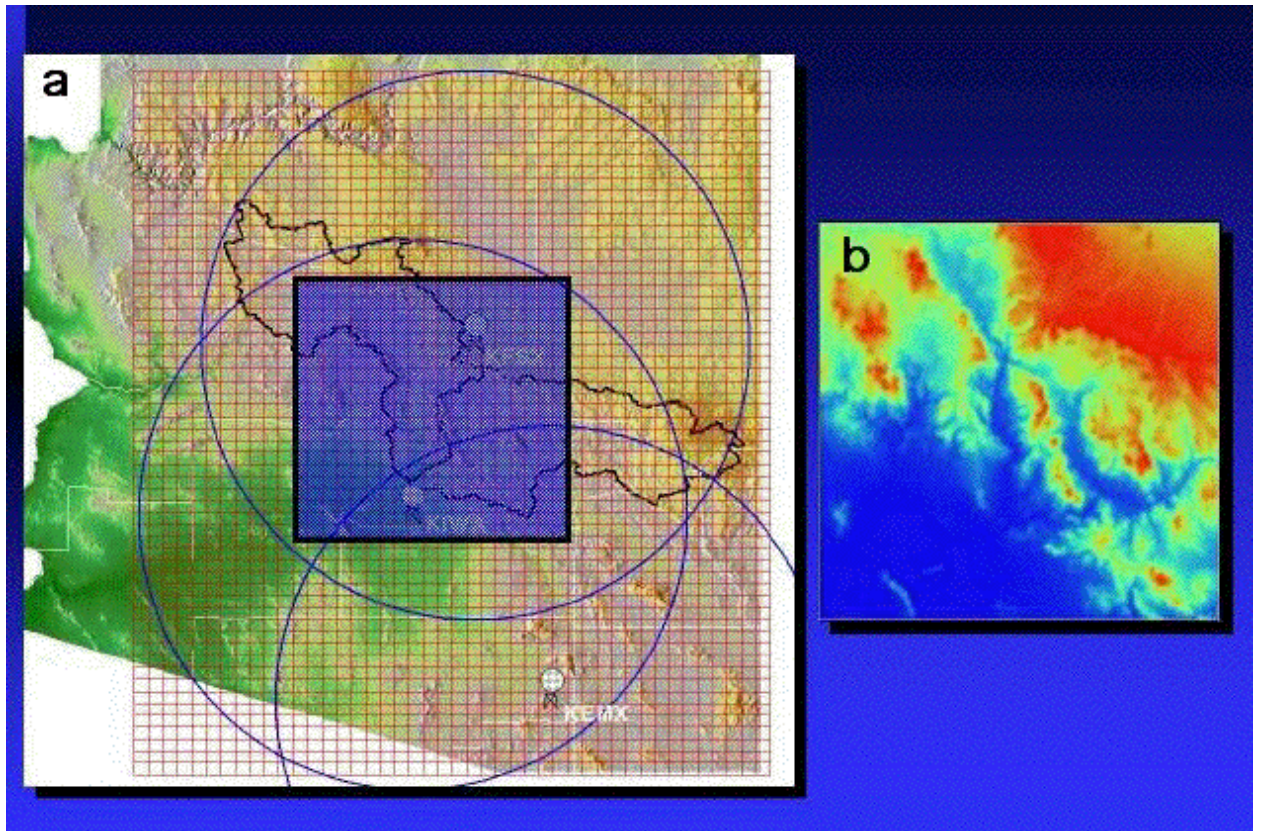


Figure 1. Left panel (a) shows an example analysis domain for central Arizona. Right panel (b) shows topography for shaded area in (a).

Fig.2a and Fig.2b show the composite reflectivity fields before and after the QC procedure. Comparing figures 2a and 2b, it is evident that the ground clutter around the KIWA radar and the AP to the northwest of the radar have been effectively removed.

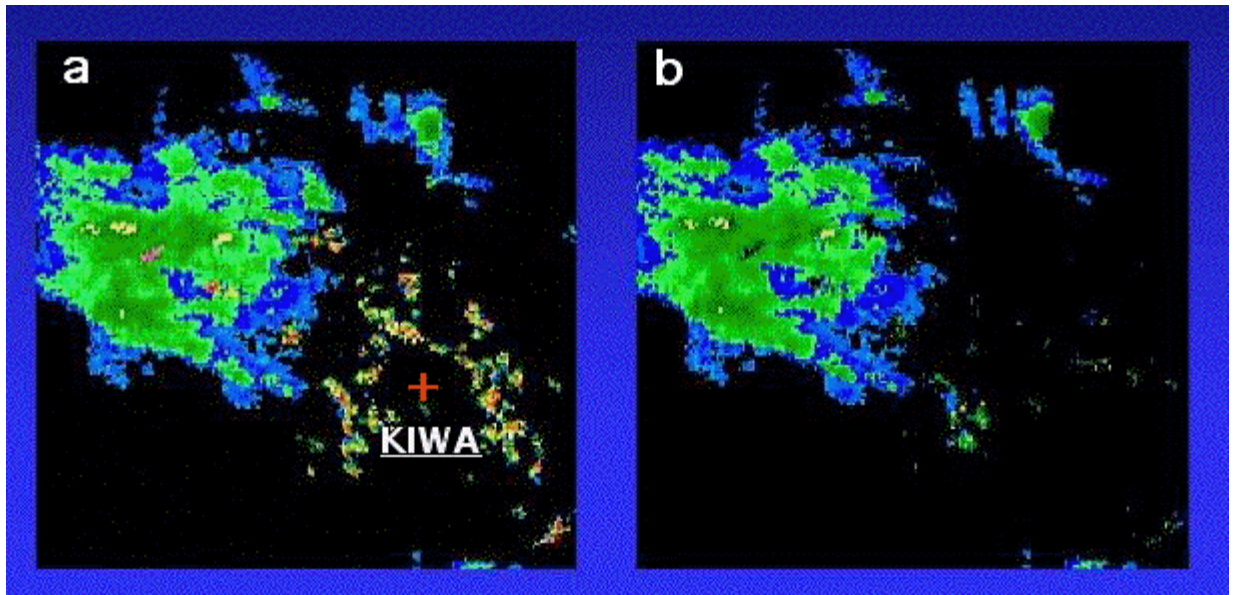


Figure 2. Left panel (a) shows an example gridded reflectivity domain. Right panel (b) shows panel (a) after application of clutter and AP filters.

Fig.3 shows horizontal cross sections of a 3D-mosaiced reflectivity field for an Arizona winter stratiform precipitation event. The cross sections were at 1km (a), 2km (b), 3km (c) and 4km (d) above mean sea level. In panels a and b of Figure 3, only KIWA data were used since the KFSX radar is at 2.3km height (nearly 2.0km above KIWA). The blockages due to the mountains to the northeast of the KIWA site can be seen in panels a, b, and c. A brightband between 1.4km to 2.3km is shown in the 2km cross section. The mosaiced reflectivity field is smooth and consistent in the overlapped region, which indicates that there were no significant calibration errors between the two radars and the mosaic scheme employed is a reasonable approach. The red lines in the figure indicate vertical cross section locations shown in Fig.4.

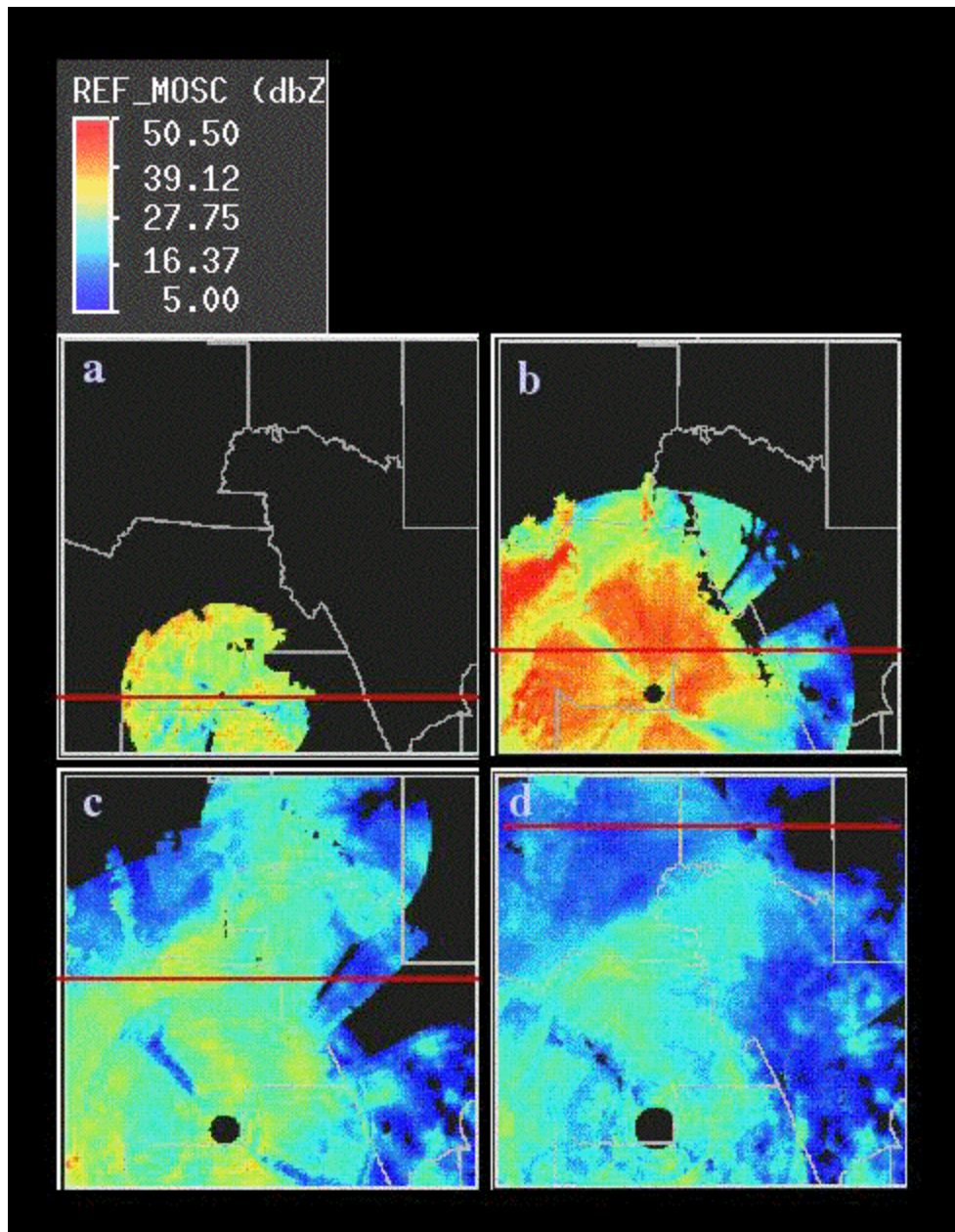


Figure 3. Panels show reflectivity at 1km (a), 2km (b), 3km (c), and 4km (d) MSL. Red horizontal lines denote cross sections shown in Figure 4.

Fig.4a shows a vertical cross-section west to east through KIWA site. The 'cone of silence' is clearly seen in the plot with data from KFSX filling the upper portion. Again, the mosaiced reflectivity from the two radars appears smooth and consistent. The brightband is clearly evident and easily identifiable in panels a, b, and c. Fig.4d shows a vertical cross-section west to east through KFSX site. The KFSX radar did not show the presence of the brightband since the radar is effectively scanning above the feature due to its high altitude location.

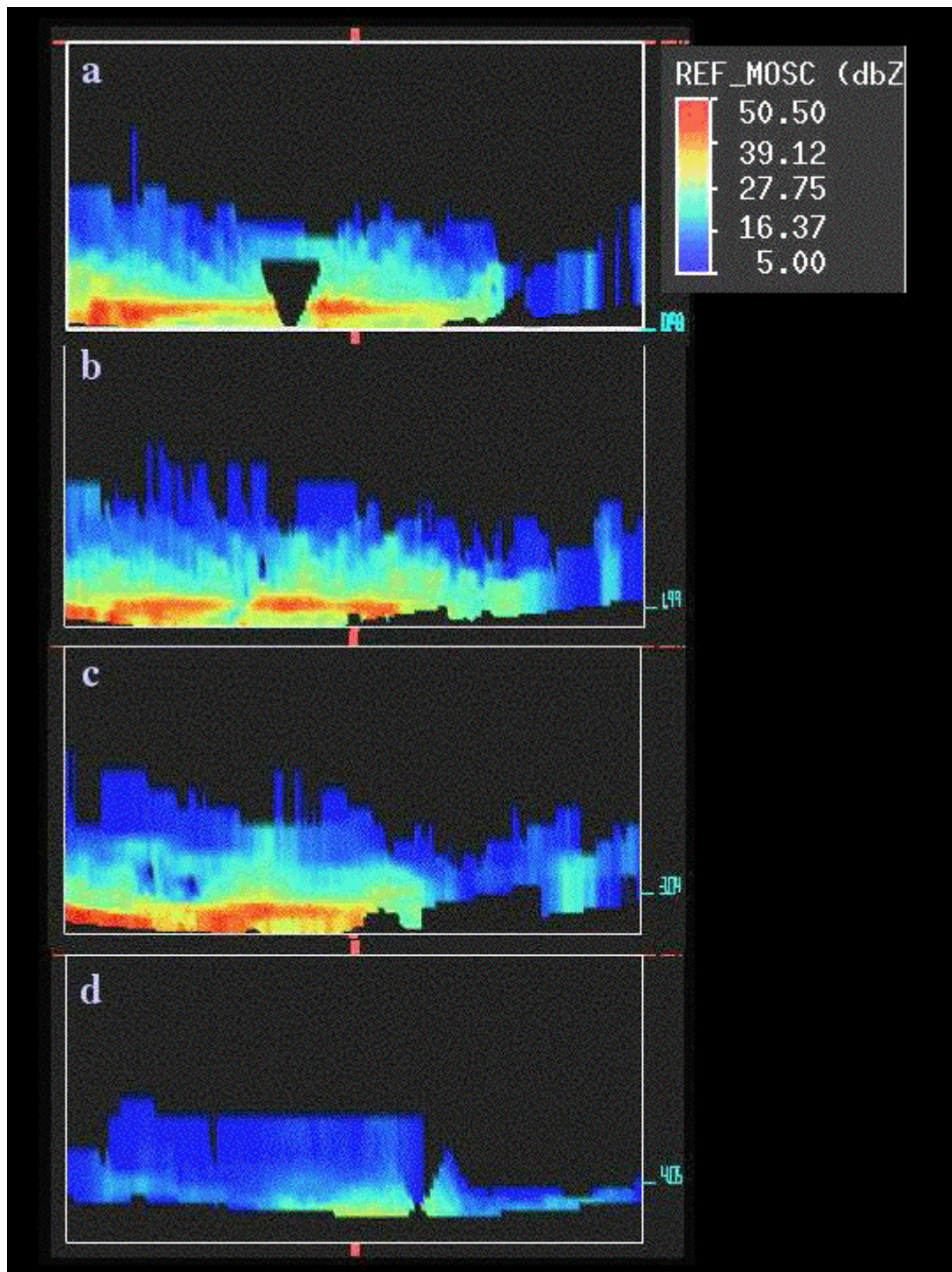


Figure 4. Vertical cross-sections corresponding to panels (a), (b), (c), and (d) from Figure 3, respectively.

Finally, collaboration with Mitre has begun to examine possible prototype products from both the single and multi-radar domains.

b) Planned efforts

The main focus during the next quarter will be to continue testing of the 3-D radar mosaic analysis scheme. We will begin testing the scheme using both a major winter and summer case studies, and will expand the current scheme to handle up to 8 radars.

Collaborations with Mitre will continue in the development of prototype products from the gridded datasets.

c) Problems/Issues – none.

d) Interface with other organizations

Mitre will be working closely with the NEPDT Task 9 contacts over the next few months.

e) Activity schedule changes

This section of the report should satisfy Milestone 00.6.9.E1. All other scheduling appears to be on time.

00.6.11 Volume Coverage Patterns

Develop and implement Volume Coverage Patterns (VCPs) relevant to the goals of the AWR PDTs.

a) Current efforts

Data were collected using the new VCPs for one severe weather event using the OSF testbed 88D (KCRI). The new VCPs are very close to finalization.

b) Planned efforts

Data collection using the new VCPs will continue during periods of weather that coincide with the availability of KCRI.

c) Problems/Issues – none.

d) Interface with other organizations – none.

e) Activity schedule changes – none.

00.6.12 Product Implementation

Explore and define implementation paths within the aviation community systems that are best for NEXRAD PDT products.

a) Current efforts

Mapping problems with the WDSS at the FAA Tech Center have been solved.

b) Planned efforts

An observational visit to the Seattle CWSU is still planned as travel schedules allow. Additionally, a visit to the Ft Worth CWSU is being planned to coincide with a significant weather event.

c) Problems/Issues – none.

d) Interface with other organizations – none.

e) Activity schedule changes – none.

00.6.14 Multi-radar Composites

Develop a vision for FAA use of high resolution, rapid update, composite products which are produced from the integration of multiple WSR-88Ds.

a) Current efforts

Work on this task has progressed on two fronts. A working group proposal is in the finalization stages. The purpose of the working group is to examine the FAA plans for WSR-88D base data processing, and the integration of other radars, and build a strategy to meet the FAA product needs in this area. Second, a multiple WSR-88D prototype system based on Task 9 for the Ft Worth ARTCC (ZFW) is under development.

Level-II tapes for the 5 May 95 Dallas hailstorm case have been acquired from KAMA, KDYX, KEWX, KFWS, KGRK, KINX, KLBB, and KTLX. These are several of the WSD-88Ds that cover ZFW. Two of the tapes have been processed to date and converted to an internally displayable format.

A tentative analysis grid has been established for ZFW. Figure 1 shows the domain with radar coverages (within 230km of range) and county lines overlaid. The color codes in Fig.1 depict the lowest and optimum beam coverages of each radar in the domain.

The domain grid uses a cylindrical equidistant map projection (i.e., constant latitude/longitude) and has a resolution of 0.032deg x 0.032deg (~3-3.5km) in both x and y directions. There are 26 levels in the vertical where the resolution varies from 200m near the ground to 1km at the top. This grid can be used to provide a general view of the weather systems developing in the whole ARTCC area. Sub-domains with high resolution (1km) could be setup for the individual traffic control zones and can integrate TDWR data for monitoring storm structures in greater detail.

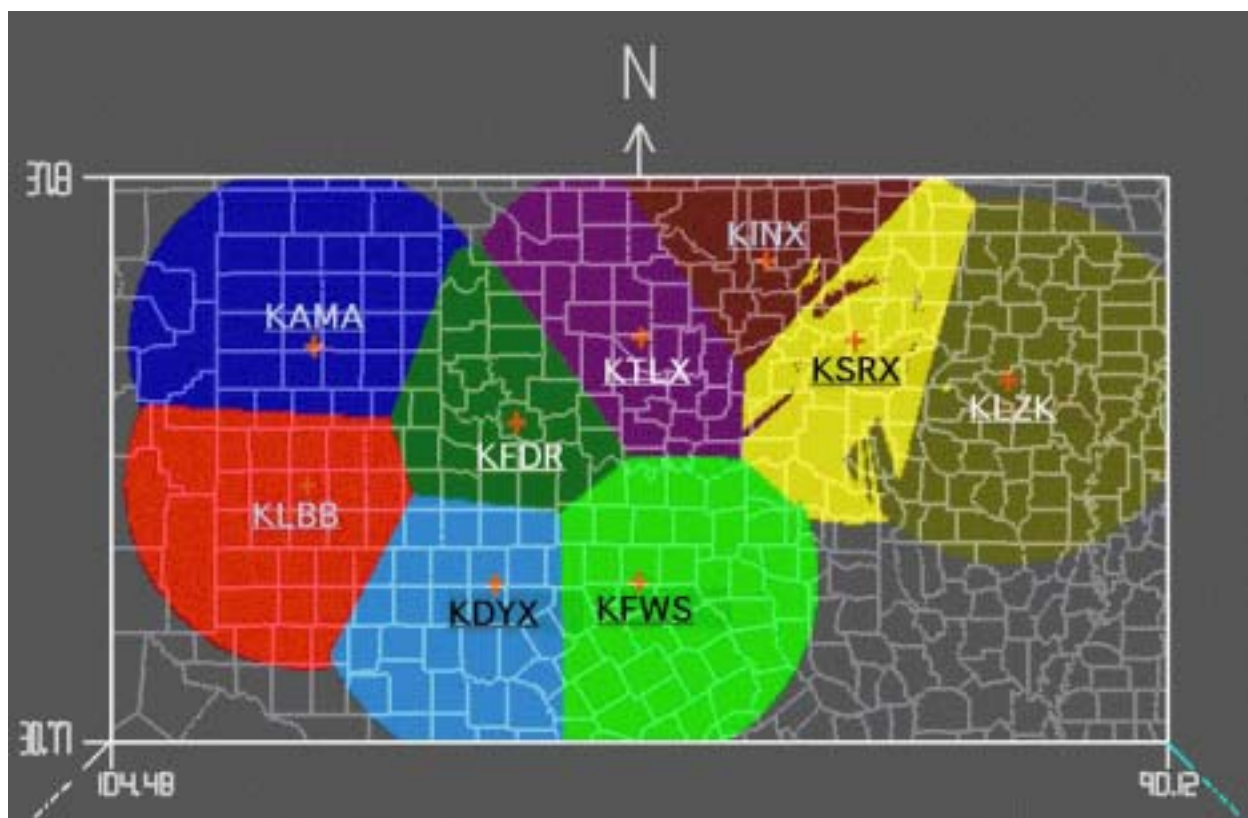


Figure 1. ZFW domain showing several possible radars that can be integrated. Colors show those areas of each radar that represents the lowest scan with no blockage.

b) Planned efforts

A final multi-radar integration working group proposal is expected to be disseminated in the near future. Those who are contacted and are interested in the group will be asked to attend a meeting at some point before the end of FY-00.

For the prototype ZFW multi-radar integration project, the main efforts throughout the next quarter will be to continue processing the data for the DFW hailstorm case discussed above and to test the scheme described in Task 9 using these data.

c) Problems/Issues – none.

d) Interface with other organizations – none.

e) Activity schedule changes – none.